NORMAL PITUITARY GLAND ON MAGNETIC RESONANCE IMAGING: SIZE, SHAPE AND APPEARANCE IN KELANTAN POPULATION

By:

DR. FAIROS BINTI ABDUL MUTHALIB

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Supervisor:

DR. MAHAYIDIN BIN MUHAMAD

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To

My Husband

who has been and will always be

a continuing source of inspiration.

To

My Son, El-Ziq.

Thanks for everything.

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Abbreviations

HRCT	High resolution Computed Tomography
CT	Computed Tomography
MR	Magnetic Resonance
mm	Millimeter
TR	Time of Repetition
TE	Time to Echo
T1WI	T1-Weighted Images
T2WI	T2-Weighted Images
PD	Proton Density
HUSM	Hospital Universiti Sains Malaysia

Abstrak

Bahasa Malaysia

Topik: Penggunaan imbasan Magnetik untuk menentukan saiz dan bentuk kelenjar pitiutari yang normal di kalangan penduduk Kelantan.

Objektif dan Tatacara: Adalah diketahui bahawa imbasan magnetik merupakan pengimejan yang terbaik bagi menganalisa kelenjar pitiutari dalam menentukan saiz dan bentuknya. Walaubagaimana pun, setakat ini tiada lagi kajian secara mendalam dijalankan terhadap penduduk Kelantan bagi mengetahui parameter kelenjar pitiutari tersebut. Tujuan kajian ini dijalankan adalah untuk menentukan anatomi kelenjar pitiutari dengan menggunakan imbasan magnetik. Ini adalah merupakan kajian yang telah dijalankan dari bulan Jun 1999 hingga Disember 2000 di HUSM. Pesakit yang tergolong didalam kajian ini adalah merupakan pesakit tidak menghadapi penyakit kegagalan pengawalan hormon atau kelenjar pitiutari. Pada amnya, imej sagital pada bahagian otak dengan tidak menggunakan kontras digunakan secara sepenuhnya bagi tujuan ini.

Keputusan: Kajian ini melibatkan 80 penduduk termasuk dengan peringkat umur diantara 0.08 hingga 87 tahun. Ketinggian kelenjar pitiutari pada lelaki adalah 5.56 mm ± (SD 1.596) manakala perempuan 5.97 mm + SD 1.76. Pada peringkat remaja, terdapat peningkatan saiz dan perubahan bentuk pada kelenjar pitiutari tersebut. Bagi kanak-kanak di bawah 1 tahun, secara amnya ketinggian kelenjar pitiutari adalah 3.56 mm, panjang 6.23 mm dan lebar 5.61 mm. Secara umumnya, intensity pada bahagian hadapan kelenjar pitiutari adalah lebij tinggi berbanding dengan pangkal otak (pons). Bahagian belakang kelenjar pitiutari mempunyai intensity yang tinggi didapati pada 62 pesakit (77.5%). Ketebalan tangkai kelenjar pitiutari yang dilihat melalui pandangan koronal adalah 1.854 mm dengan purata 0.8 – 3.9 mm.

Kesimpulan: Secara keseluruhannya, kajian ini telah menunjukkan terdapat hubung kait diantara umur, saiz dan bentuk kelenjar pitiutari. Ia juga memberikan data dan informasi mengenai kelainan yang dianggap normal pada kelenjar pitiutari.

Abstracts

English

Topic: Normal pituitary gland on MRI: Size, shape and appearance in Kelantan population.

Objective and Methods: Magnetic Resonance Imaging provides sufficient high resolution to analyzed the size, shape and appearance of the pituitary gland. So far, no research has been performed with regards to the morphology and measurement of pituitary gland in Kelantan population. The aim was to determine the measurement and morphology of normal pituitary gland in the population of this state. This prospective study was done from June 1999 till December 2000 in HUSM, Kubang Kerian. Inclusion criteria for this study include no clinical finding suggestive of pituitary disease or significant endocrine disturbance for the initial radiological referral. Midline non-contrast-enhanced T1-Weighted Images (T1WI) via sagittal images was used exclusively for the analysis.

Results: Total of eighty patients were included in this study with age of patients range from 0.08 to 87 years. The mean height of

the gland in male patient was 5.56 mm ± (SD 1.596) and for female 5.97 mm ± SD 1.76. In the age group of 10 to 19 years old, an increase in size and convexity of the pituitary gland presence during adolescence. The mean height, length and width of the infant pituitary gland were 3.56 mm, 6.20 mm and 5.61 mm respectively. The signal intensity in the anterior lobe of the pituitary gland in infant was of high signal intensity relative to the pons. The posterior lobe demonstrated high signal intensity in 62 patients (77.5%). The mean diameter of the infundibulum on coronal view was 1.854 mm with range of 0.5 to 3.9 mm.

Conclusion: This study confirms that there were correlation between the age pituitary size and shape. It also provides data and information regarding normal variants of the pituitary gland.

SECTION ONE:

Introduction and Literature-Review

1.1 Introduction

Increased awareness of the symptomatology of pituitary disease, along with the ready availability of pituitary hormone assays, has resulted in earlier diagnosis of pituitary tumours. Frequently, these tumours are diagnosed biochemically before they are demonstrable radiographically; even using high-resolution Computed Tomography (CT). With modern treatment approaches, adequate and safe visualization of the tumours is becoming increasingly important.

Familiarity with normal appearance, size and shape of normal pituitary gland is needed before pathological morphology could be determined. Initially, pituitary gland is easily evaluated by means of high-resolution Computed Tomography (HRCT). It is best demonstrated either directly on coronal scans or indirectly from data obtained in the axial plane and reformatted into coronal and sagittal images. The use of HRCT scans for the diagnosis of pituitary microadenomas is well established. The diagnosis depends on alterations in the configuration and contrast enhancement of the pituitary gland. Pituitary microadenomas usually result in increase in gland height, producing a convexity of the superior border of the

gland *(Samuel, 1988)*. The tumour itself can appear as a region of low attenuation within the contrast-enhanced pituitary gland. However, this appearance is not specific for pituitary microadenomas, which also can cause by other abnormalities such as pituitary cyst. Furthermore there are also limitations of CT for evaluating pituitary gland. The limitation is due to presence of bony artifact.

Recently, with advance in research, Magnetic Resonance Imaging (MRI) of the pituitary gland has now play an important role for diagnosis of pituitary disease. As mentioned earlier, familiarity with normal appearances of pituitary gland is essential before conclusion of the underlying disease can be made.

MRI has several theoretical advantages over other imaging modalities when imaging pituitary gland *(Benjamin Glaser, 1986)*. The lack of bone artifacts and the availability of multiplanar imaging make it possible to discern the fine architecture of the gland. Furthermore, since the MRI is the result of the interaction of at least three separate tissue characteristic (proton density, longitudinal relaxation time-T_1, transverse relaxation time-T_2), it is possible that, by choosing the proper

pulse sequences, one may be able to detect very subtle changes in tumour 'consistency'.

MRI has been proven to be an accurate and useful modality for the evaluation of pituitary gland. There is a need to be familiar with the size of the normal pituitary gland for the evaluation of patients with pituitary diseases such as hypopituitarism and pituitary microadenomas.

MRI has broadly sustained criteria developed for CT for the normal measurement and configuration of the adult pituitary gland. However currently, there is no study regarding the measurement and morphology of normal pituitary gland in Kelantan population, which is predominantly made up of Malays.

The aim of this study is to determine whether there are sex and age differences of pituitary gland within the Kelantanese population.

1.1.1 Anatomy Of The Pituitary Gland

The skull base is formed from the membranous bone and cartilage, perforated by nerves, arteries and veins. The base of the skull consists of the anterior, middle and posterior compartments. The floor of the anterior cranial fossae is formed laterally by the roof of the orbits and in the midline by the cribriform plate. The bony compartments of the floor of the middle cranial fossae are the temporal bones and the greater wings of the sphenoid bone.

The sella is situated in the midline between the anterior and middle cranial fossa of the skull base. The sella is a saddle-shape osseous structure with the anterior component identified as the tuberulum sellae, inferiorly forming the floor and posteriorly, the dorsum sella and lined by lamina dura.

The normal pituitary gland sits in a bony socket called the sella turcica, flanked on either side by the cavernous sinus and above by the optic chiasma. The human pituitary gland can be divided into two parts. The posterior pituitary or neurohypophysis is a direct extension of the central nervous system, whereas the anterior pituitary or adenohypophysis is derived from Rathke's pouch.

(i) Anterior lobe or adenohypophysis

The superior hypophyseal arteries through the portal system supply the adenohypophysis or the anterior lobe of the pituitary gland, indirectly. The superior hypophyseal arteries, which arise from the supraclinoid portion of the internal carotid and posterior communicating arteries, supply the median eminence and the infundibulum (pituitary stalk), first through formation of extensive capillary networks around these structures, now called the primary portal system. The blood is then collected within the infundibulum that open into the vascular sinusoids within the anterior lobe of the pituitary gland. These sinusoids constitute the secondary plexus of the pituitary portal system or the secondary capillary bed. The anterior pituitary secretes growth hormone, prolalctin hormone, Adrenal-Corticotrophic-Hormone (ACTH), Lutheal Hormone (LH)/Follicular Stimulating Hormone (FSH) and Thyroid Stimulating Hormone (TSH).

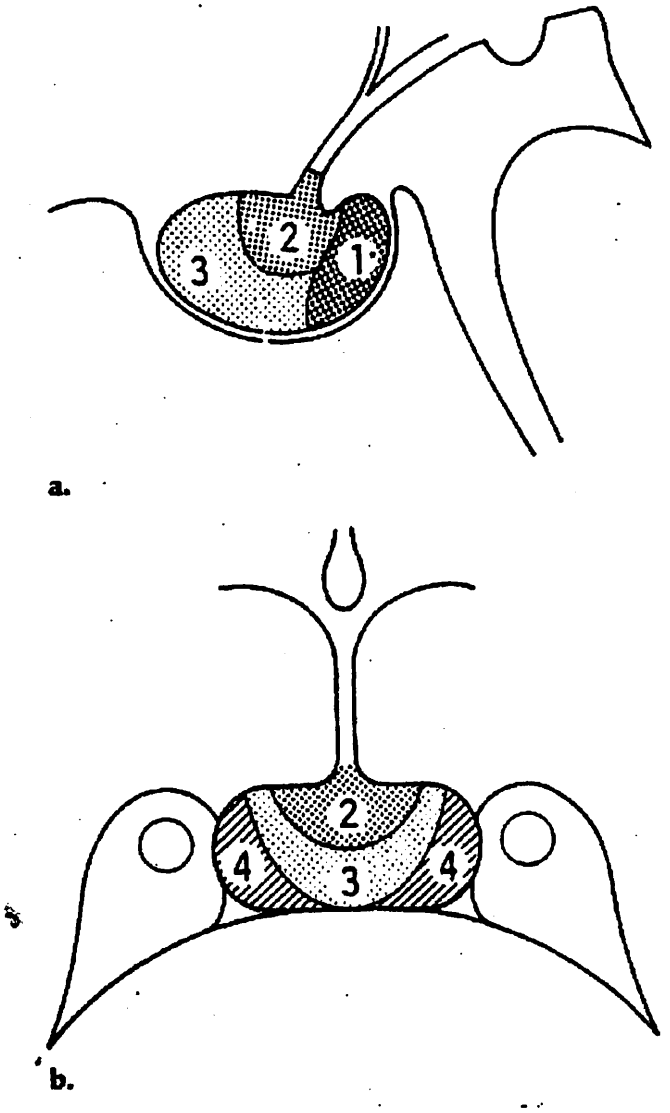

Figure 1.1: Normal pituitary glands in sagittal **(a)** and coronal **(b)** section: Posterior pituitary lobe (1), anterior pituitary lobe adjacent to the junction with the infundibulum (2), distal portion of the anterior pituitary lobe (3), and lateral portion of the anterior pituitary lobe (4) in the coronal plane are illustrated.

(ii) Posterior lobe or neurohypophysis

The neurohypophysis or posterior lobe of the pituitary gland receives separate and direct arterial supply from the inferior hypophyseal branch of the meningohypophyseal artery that arises directly from the cavernous portion of the internal carotid artery. The posterior pituitary secretes both vasopressin and oxytocin hormone.

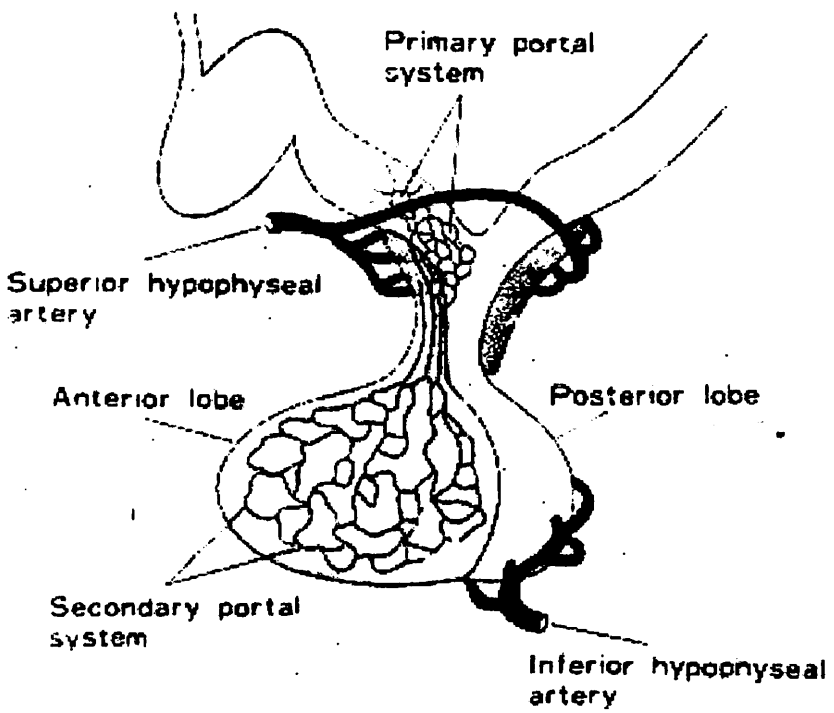

Figure 1.2: Blood supply in pituitary gland. The anterior pituitary lobe is supplied by the superior hypophyseal arteries indirectly through the pituitary portal system. The posterior pituitary lobe receives separate and direct arterial supply from the inferior hypophyseal arteries.

(iii) Infundibulum or pituitary stalk

The pituitary gland has it own stalk or infundibulum. The infundibulum can be visualized in MRI either on coronal or sagittal planes. MRI can also determine the diameter of the infundibulum, thickness and deviation or tilt as a normal variant. Deviations of the pituitary stalk or infundibulum on coronal images in MRI generally have been used to support the presence of microadenomas *(Kornrtich L, 1998)*. However, other researches have mentioned that slight deviation or tilt of the pituitary stalk may not necessarily indicate abnormality. Apart from deviation, in condition such as empty sella syndrome, where cerebrospinal fluid (CSF) occupies the sella and the pituitary gland constitute less than 50% of the volume of the sella *(H. Newton, 1982)*. It is usually seen in 9% of the general population. The empty sella usually is an incidental finding most commonly seen in women with an in-complete diaphragma sella. The diagnosis can be made in coronal CT, although it is easier to evaluate on coronal or sagittal MR images. The sella is usually enlarged. A normal or elongated infundibulum

connects the tuber cinereum with the small pituitary gland in the sella.

Therefore, the anatomical associations have important ramifications on pituitary physiology and pathophysiology. Tumours in the suprasellar region can disrupt the pituitary stalk and cause both anterior and posterior hypopituitarism. Blunt head trauma can cause tearing of the stalk and hypopituitarism. Interruption of the blood supply to the anterior pituitary will result in infarction of the gland giving rise to Shechan's Syndrome. It is associated with anterior pituitary dysfunction but rarely affects the function of the posterior pituitary.

1.2 Literature-review

Magnetic Resonance study of the pituitary gland requires a high-resolution thin slice thickness through the sella region and high-resolution matrix (256 x 256). The appearance of the pituitary gland in MRI is best evaluated in the sagittal and coronal images. In the neonatal period, the pituitary gland is hyperintense in T1-Weighted images (T1WI) without appreciable difference between the adenohypophysis and neurohypophysis *(H. Newton, 1982)*. In adults in T1-Weighted images (T1WI), which are short time of repetition (TR) and time to echo (TE) sequences, the anterior part of the pituitary (adenohypophysis) has intermediate signal on T1WI and intense homogeneous bright signal following contrast enhancement. In contrast, the cortical bone of the sella and the cerebrospinal fluid in the suprasellar cisterns have negligible signal. The posterior lobe has normal higher signal intensity than the anterior lobe due to the presence of phospholipids in neurosecretory granule membranes that have a function in hormone secretions *(H. Newton, 1982)*. Fat in the marrow of the dorsum sella and within the posterior-inferior pituitary fossa also appears as a

region of hyperintense signal in MR images. Small venues channels, which have a negligible signal because of flowing blood, are prominent at the lateral part of the pituitary gland. In long time of repetition (TR) and time to echo (TE) T2-Weighted Images (T2WI), the gland has a nearly homogeneous bright signal, which however, is less intense than that cerebrospinal fluid (CSF). The diaphragm sella is demonstrated in coronal spin density (longer time of repetition and time to echo) images as a transversely oriented thin band with a negligible signal *(H. Newton, 1982)*.

There are many studies regarding normal pituitary gland from infant till elderly patients. The studies include appearance, size and shape of the normal pituitary gland. However so far, no specific study was performed on local Kelantan population. Therefore, the aim of the study is to indicate that there are differences in age and sex regarding the appearance, size and shape of the pituitary gland.

Several MR studies had established standards for linear and area measurements of the pituitary gland over a broad range of ages.

T. David Cox et al (1991) had done a study regarding changes in shape, size and signal intensity of the normal pituitary gland during the first year of life with MRI and found that a progressive increase in the length but not in height of the gland was seen through the first year of life. They found that upward convexity of the gland was seen in 63% of neonates less than 1 month of age. The neonatal and young infant pituitary gland is rounder, brighter and relatively larger during the first 2 months of life than in later infancy.

Measurement of the height of pituitary gland was performed on MR images of 213 subjects with no known or suspected pituitary or hypothalamic disorders. This study was done in department of radiology, Kanazawa University School of Medicine, Japan by *Masayuki Suzuki et al (1990).* The results showed that between of ten to sixty-nine years, range of the pituitary height were greater in female than male. The maximum of the mean height was observed in the ten to nineteen years of age groups of both genders. The heights gradually decrease with increasing age after 20 years old. There were no subjects with a height of > 9.0 mm in females or > 8.0 mm in males.

Brighton Mark et al (1984) did a study regarding different signals within the normal pituitary fossae and height of

the normal pituitary gland. The results showed the height of the normal pituitary gland in sagittal images was usually less than 8 mm and the upper surface was flat or concave.

Another study regarding normal appearance of the pituitary gland in the first 2 years of life which was performed in department of Radiology University of California by *Dietrich RB. et al (1995)*. The findings suggested that there was a statistically significant difference in the signal intensity of both anterior and posterior lobe of pituitary gland and in the shape between children who are younger and older than six weeks of age and older than twenty-seven weeks of age. These changes may reflect the ongoing changes in pituitary hormones in the newborn period.

Doraiswamy PM. et al (1992) had done another studies using MR for assessment of pituitary gland morphology for age and gender related differences. The findings showed that for all subjects aged between twenty-one to eighty-two years, there was inverse correlation with pituitary height and cross sectional area. Age specific gender differences were also present in pituitary height and area with a convex upper margin more common in females.

Allen D. Elster et al (1991) had done a study regarding size and shape of the pituitary gland during pregnancy and post partum using cranial MRI. The pituitary gland enlarges through out pregnancy but never exceed 10 mm in height during pregnancy. Increase in gland convexity also correlates with progression of pregnancy.

Another study by *Allen D. Elster et al (1990)* regarding changes in both size and shape of normal pituitary gland might be altered by pubertal hyperplasia. They found that, in adolescents definite evidence for physiological (pubertal) hypertrophy was seen in both sexes, although much more prominent in girls. There were significant changes in size and shape of pituitary gland in girls, while in boys there were transformations in size only. In this study, there were no pituitary glands found to be more than 6 mm in height in the patients younger than twelve years old. Young adults between twenty-one to thirty years old had significantly smaller gland than teenagers of the same sex. Significant variants in the shape of the pituitary glands according to the patients' sex and age were also present. Convex upper margins were seen in 56% of teenage girls, while this shape was noted in only 18% of the remaining patients of either sex. In eight of thirty-two teenage

girls (25%) the pituitary glands were nearly spherical on sagittal images.

Yuji Sakamoto MD. et al (1991) had done a study regarding contrast material enhancement patterns of the normal pituitary gland. The results showed that the earliest contrast enhancement was seen in the infundibulum and posterior lobe of the pituitary gland *i.e.* within twenty seconds, followed by gradual contrast enhancement of the anterior lobe within eighty seconds after gadolinium-pentetate dimeglumine (Gd-DTPA) injection.

Dinc H. et al (1998) did a study regarding pituitary dimensions and volume in pregnancy and postpartum with MR assessment. The results showed that the pituitary gland volume, height, width, length and convexity increased during pregnancy with the highest values noted during the first three days of postpartum.

Study by *Nadia Colombo et al (1987)* regarding the appearance of posterior pituitary gland on MRI demonstrated high signal intensity in 69% of patients. The frequency of hyperintensity and the appearance of posterior pituitary lobe showed no significant difference with patient age.

Another study by *Katsumi Hayakawa et al (1989)* regarding development and aging of brain midline structures, assessment with MRI via mid-sagittal images. They found that in adults twenty-one to forty years old, the average height of the pituitary gland was 4.8 mm 1.0 (mean ± standard deviation) for men and 6.0 mm ± 0.8 for women. There was a statistically significant difference between men and women ($p<0.01$). The growth in pituitary gland height was linear for the first decade, during which no sex difference was observed. A growth spurt of gland was observed in female subjects ten to fifteen years old.

M. Sumida et al (1994) studied regarding the position of the normal pituitary gland using gadolinium-enhanced MR Imaging. The imaging findings were compared with the position found at surgery for pituitary adenoma in twenty-five patients. Using T1-Weighted Imaging (T1WI), the anterior lobe could be differentiated from posterior lobe on sagittal imaging in fifteen patients (20%) and in coronal imaging in four (16%). The high intensity of the posterior lobe could be delineated using T1-Weighted Images (T1WI) on sagittal imaging in thirteen patients (52%). The normal pituitary gland, which enhanced more strongly than the tumour, could be differentiated using gadolinium-pentetate-dimeglumine-

enhanced (Gd-DTPA) MRI on the sagittal images in twenty-two patients (88%) and on the coronal images in seventeen patients (68%).

Yukio Miki et al (1990) did a study regarding enhancement pattern of the normal pituitary gland and pituitary adenomas on gadolinium-pentetate-dimeglumine-enhanced MRI. They found that the normal pituitary glands showed maximum enhancement on the first or second image following the administration of gadolinium-pentetate-dimeglumine, followed by gradual signal reduction through the later images, whereas pituitary adenomas reached a peak of enhancement later and showed slower signal reduction than normal pituitary gland.

A study regarding the enhancement of the normal pituitary via gadolinium-petentate-dimeglumine-enhanced MR Imaging was conducted in University of California by *Diane R. Newton et al (1989).* The study noted that the normal pituitary gland, infundibulum and cavernous sinus enhanced immediately after the administration of gadolinium-DTPA, allowing contrast differentiation between the enhancing normal glandular tissue and low-intensity microadenomas possible.

A study regarding anterior and posterior lobes of the pituitary gland was carried out by *Ichiro Fujisawa et al (1987)* in Kyoto University School of Medicine by using 1.5 Tesla MRI. Pituitary glands of sixty normal volunteers (thirty men and thirty women) with age ranges from eighteen to forty-two years old were studied by using 1.5 Tesla MRI. The results showed that the posterior part (PP) of the pituitary fossae of all subjects demonstrated the highest signal on T1-Weighted Images (T1WI), which was indistinguishable from fatty tissue. The volume, height, width and length of both anterior and posterior lobes were also analyzed. They found that the volume and height of the anterior lobe of women were larger than those of men. The mean gland height was 5.1 mm (standard deviation 1.2) in men and 7.2 mm (standard deviation 1.5) in women. The convex margin upward was demonstrated on coronal images in seven (23%) men and sixteen (53%) women and on sagittal images, twelve (40%) men and twenty (67%) women respectively.

Study regarding the infundibulum tilt was performed in University of Texas Health Science Center by *Hamid Ahmadi et al (1990).* The aim of the study was to determine the prevalence of pituitary infundibulum deviation or tilt as a normal variant in coronal images on MRI. They found

that 46% out of fifty patients had a more or less pronounced tilt of the pituitary stalk. This tilt was due to developmental lateral eccentricity of the pituitary gland in relationship to the midline of the brain in 34% and to ontogenie eccentric insertion of the pituitary infundibulum off the midline of the gland in the other 12%. This high frequency of stalk deviation in patients without pituitary disease suggests that such displacement by itself should not be used to support the presence of pituitary microadenoma on MRI or CT.

Another research done by *Yukio Miki et al (1992)* regarding contrast enhanced area of posterior pituitary gland in early dynamic MRI. They found that a well-defined forced area with marked enhancement was seen in the posterior portion of the pituitary gland on the first image after injection of gadolinium-DTPA. The size of the early enhancing area in the posterior pituitary was compared with the high signal of the posterior pituitary or the pre-contrast image. The enhancing area in the posterior pituitary was larger than it was on the pre-contrast image in 39% (ten cases).

Benjamin Glaser et al (1996) had done a research regarding pituitary gland base by using MRI. The height of gland was measured on both the sagittal and coronal projections,

whereas the length was determined on the sagittal view and the width on the coronal section. The normal pituitary dimensions include anterior-posterior (length), superior-inferior (height), right to left (width) and volume (length x height x width x $\pi/6$), which measure 0.1 to 1.2 cm, 0.6 to 0.9 cm, 0.7 to 1.0 cm and 0.28 to 0.41 cm^3 respectively. The result for the normal pituitary dimension was obtained from seventeen control subjects, thirteen of whom were male and four female aged twenty to fifty-nine years old. The control subjects are either healthy volunteers or patients with no known or suspected pituitary disease.

Study regarding the anterior pituitary gland intensity in pregnancy was performed in Faculty of Medicine Kyoto University by *Yukio Miki et al (1993).* In this study, the authors obtained a midline sagittal T1-Weighted Images of the pituitary gland in thirty female patients, five of whom were pregnant, two postpartum and twenty-three non-pregnant child bearing age and without evidence of pituitary disorders. They found that in pregnant and postpartum patients, the relative signal intensity of the anterior lobe compared with the pons was statistically higher than that in the control group ($p<0.001$). The authors believed that the hyperintensity of the anterior pituitary

lobe in pregnant and postpartum patients is a physiologic variation. Because the anterior lobe of an infant may also be hyperintense on T1-Weighted Images and that the anterior lobes of an infant and a pregnant woman are histologically similar, the mechanism responsible for the hyperintensity in each case may be the same.

Ichiro Fujisawa et al (1992) had done a research regarding the originating factors that cause hyperintensity signal of the posterior pituitary on T1-Weighted Images. It was an experimental study on six rabbits, which were imaged on a 1.5 Tesla device before and after two weeks feeding with hypertonic solution (phase I) and regular water for another two weeks (phase II) for four rabbits. The plasma anti-diuretic hormone (ADH) level was monitored during each imaging session. They have suggested that the probable source of the hyperintense signal in the posterior part of the pituitary gland is the anti-diuretic hormone (ADH). Long-term feeding of hypertonic saline solution is known to stimulate the release of anti-diuretic hormone (ADH) in neurosecretory granules from the axon terminals in the posterior lobe. If this release exceeds the synthesis and transport by neurosecretory granules, their number will decrease. In those subjects, the signal intensity of the

posterior lobe decrease at the end of phase I, and the hyperintense signal in the posterior part reappeared at the end of phase II. The neurosecretory granules in the posterior lobe significantly diminished in number in phase I. Plasma anti-diuretic hormone (ADH) levels significantly increased in phase I and returned to their normal range in phase II. These clear correlations between MRI finding and hormonal and histochemical results strongly suggest that the source of the hyperintense signal of the posterior lobe is the neurosecretory granules containing anti-diuretic hormone (ADH).

Walter A. Hull et al (1994) had done a research regarding pituitary MRI in normal human volunteers to determine the prevalence lesions of pituitary adenoma in symptomatic persons. The mean gland height in the hundred volunteers was 6.9 ± SD 0.1 mm. It was greater in women (7.1 ± SD 1.3 mm) than in men (6.6 ± SD 1.2 mm; p=0.008). Upward convexity of the superior surface of the gland was limited to one side in twenty-one persons (twelve right, ten left; and occurred centrally in eleven patients).

Ichiro Fujisawa et al (1987) performed systemic analysis of the anterior and posterior lobes of the pituitary gland assessment by 1.5 Tesla MRI. All the images were analyzed using

all three planes with different pulse sequences. On T1-Weighted Images (T1WI), the posterior part of the pituitary fossae of all subjects showed the highest signal, which was indistinguishable from fatty tissue. This signal corresponds to the posterior lobe and not intrasellar fat because its shape, size and position are compatible with the former. Its signal intensity differs from that of fatty tissue in proton density-weighted images (PDWI) and T2-Weighted images (T2WI) and the absence an intrinsic chemical shift artifact characteristic of fat.

SECTION TWO:

Objective and Methodology

2.1 Objective

Objective of this study are:

- To determine the normal appearance of the pituitary gland base on pituitary height, width, length and volume according to the age and sex from birth to adulthood with particular emphasis on the adolescent.
- To characterize further phenomenon of physiologic (puberty) hypertrophy, especially with regard to its age and sex dependent features.
- To analyze changes in shape signal intensity of the pituitary glands in relation to the age and sex.
- To analyze the thickness of the infundibulum or pituitary stalk in relation to age and sex.

The null hypothesis of this study:

- There is no different in size, shape and appearance of the pituitary gland in Kelantan population.